Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-61-RC1, 2019

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Global sinusoidal seasonality in precipitation isotopes" *by* Scott T. Allen et al.

Anonymous Referee #1

Received and published: 5 April 2019

General comments: This manuscript describes a method to determine sine curve fits to the seasonal cycle of precipitation isotopes from stations around the globe. Interpolated maps of seasonality and a database of sine curve parameters were produced (not available for review). Overall the paper is well written, but ambitious in scope. The paper lacks an adequate explanation of how this work advances upon previous work, and needs more attention to sources of uncertainty in the analysis. With these improvements, the results presented here should be a solid contribution to the field of isotope hydrology.

Specific comments:

Abstract: this is somewhat disorganized, and would be improved by aiming toward a straightforward description of the problem or question addressed, the analyses done,

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and the significance of the result.

P 2 L 4-10: Authors note that interpretive studies may ignore either the spatial or temporal aspect of the isotopic signal. Please explain further how the current approach improves on the interpolated seasonal data that are already available, where mean monthly isotope values can be downloaded from an online calculator for a set of spatial coordinates (isoscapes.org). The advancement represented by the approach in the current manuscript needs to be clearly described.

P 4 L 13-15; P10 L 13-14: Amount weighting is important for hydrological interpretations; please discuss whether amount is best included within the sine fitting procedure for an area, or whether amount should be included at the level of a regional or local study, where it would be used to weight the robust-fit seasonal values?

P 4 L 20: mean annual precipitation amount globally seems to have low predictive value for isotopic composition (table 2), does this parameter combine rainfall with snow water equivalent (SWE) measurements, and are those accurate enough to make this a useful parameter for station characterization?

P 5 L 1-2: are the areas and stations where there is no sinusoidal seasonal cycle clearly denoted in the database?

Section 2.3: Maps of predicted global precipitation isotope seasonality (sine curve parameters) and precipitation amount were generated with an interpolation scheme. Was any model validation performed by holding back a portion of station data and analyzing differences between measured and predicted isotopic value? This type of assessment should be done for the precipitation isotope seasonality and rainfall amount values.

P 6 L 15, L26-31, P7 L 1-5: It is not so surprising that tropical locations have seasonal cycles if one considers that land surface temperatures are not the primary control. Feng, X. et al., 2009, JGR, doi:10.1029/2008JD011279 (already cited); Scholl, M. et al., 2009, WRR, doi:10.1029/2008WR007515; Bailey, A. et al., 2017, JGR,

doi:10.1002/2016JD026222 may provide a broader understanding of seasonal isotope patterns in the tropics. Condensation/equilibration temperatures can be very low and vapor sources isotopically depleted in tropical regions, where convective precipitation systems (esp. in the ITCZ) reach well above the freezing layer. The position of Hadley cell boundaries seems somewhat overemphasized here; atmospheric circulation factors that control isotope patterns (prevailing winds, atmospheric structure, dominant seasonal weather patterns) - have been identified in isotope-enabled GCM studies for tropical and temperate latitudes.

P 7 L 4: Precipitation d-excess globally exhibits a seasonal cycle, please see Pfahl and Sodemann, 2014, doi:10.5194/cp-10-771-2014. We would expect similar behavior for lc-excess, but with a less-distinct amplitude.

P 8 L 26-28: "grid-cell means are not always representative of individual station locations, as demonstrated by the mismatch between the elevations of monitoring stations and the mean elevations of the pixels they occupy (Figure S5)". Given that elevation is a major factor in isotopic composition of precipitation, how does this reflect on the interpolation and smoothing used to produce the maps? Should the map result be presented at the global scale, given that authors (appropriately) aim to "produce global maps and data that support stable isotope applications," and "predict individual-month values from a sine curve (P 9 L 6)"? Regional maps, where topography is presumably better represented, would seem to be a better approach and I encourage revision of this paper to include those maps and data sets, or at least a thorough explanation of the process of creating and calibrating regional maps.

P 10 L 5-7: Please identify "regions where "seasonal precipitation isotope dynamics are well described by sine curves," and where they are not, in a table or specific map. This would make the material much more informative to users of the data and prevent improper use of interpolated values. It is important to identify places where sinusoidal cycles cannot be used, especially given the discussion on p. 10 where authors suggest numerous applications for the data.

P 10 L 26: there are other references for this concept, please improve this section by including citations specific to the biological and geological processes that are noted; to improve the paper organization, consider moving material from lines 5-35 to the introduction, then briefly revisiting here.

P 11: “The *majority* of stable isotope time series measured at 653 precipitation isotope monitoring stations show significant sinusoidal seasonal cycles in precipitation isotopes” and “In Supporting Information 2, we provide fitted sine curves and site metadata for *all* 653 precipitation monitoring stations” . . . Given that some of the stations patterns do not have a sinusoidal cycle, why are sine curves being provided for stations where they are not applicable?

P 11 L 15-20: Supporting information 2 and 3 were not available for peer review and have not been evaluated. In this section, please provide details about the sources of raw data from “publicly available datasets” that were used in this work, with citations, attribution or links, to aid further research by others.

Figure S3 – this is not very informative at the coarse scale shown here - the reasons underlying phase shifts between temperature and isotopes (seasonality) globally are fairly well understood and should be addressed separately for different climate zones, if included at all. Figure 3b provides much the same information.

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